sary information, and serious losses were prevented where the measures advocated were carried out. The outstanding feature concerning fruit crops was an outbreak of the pear thrips in British Columbia, and investigations of its life-history and means of control are now being conducted. The warble-fly is also a problem of great importance, especially as the two common species of Hypoderma are extending their range in Canada, through the introduction of cattle from infested areas. A definite method of control, by legislation or otherwise, is an urgent need not only in Canada, but also in the British Isles.

Among other topics, insects affecting the household and public health claimed much attention, also the protection of birds and mammals, and the arrangement of the national collections of insects.

A. D. IMMS.

EDOUARD SARASIN, (1843–1917).

WHILE the best young shoots are being ruthlessly destroyed the mature grain is being harvested. Edouard Sarasin has passed away. In him Science deplores the loss of a distinguished physicist, and Geneva a great man of an historic race, whose traditions, however, do not cease with him.

The place which Sarasin held in the world of science was in no way due to official position. He was at no time a professor at the university. The admirer of his work who sought him at the University of Geneva did not find him, and was told: "Edouard Sarasin? He is Maire of Grand Saeonnex." In answer to a puzzled question as to his academic position they would say: "He is President of the Société Helvétique, and editor of the Archives des Sciences physiques et naturelles."

Sarasin's experimental work, which was of the first order, was carried out at a private laboratory, often in collaboration with friends, whose names are no less illustrious than his own. He was not the head of a school, but a bright star in a galaxy. These men of science grew up under the influence of Auguste de la Rive; and Sarasin's first essay, dealing with electric discharges in rarefied media in presence of a magnet, were prompted by that great master. At the same time, under Soret, he was obtaining results which have become classical; among these we may mention the refractive indices of quartz, Iceland spar and fluorspar, still printed in the tables.

It was however in collaboration with Lucien de La Rive, the son of Auguste, that Sarasin's best known work in physics was achieved. This consisted in the experimental development of the Maxwell-Hertz theory. The discovery of "multiple resonance" is one of the results due to them. It is in virtue of this property that, for instance, a Marconigram may be picked up in transmission by any resonator. The last scientific work with which Sarasin was, only recently, engaged, consisted in delicate experiments on radio-activity carried out in conjunction with Tommasina.

At Geneva, however, the man of science cannot remain mewed up in a laboratory. Nature tempts him with her beauty and her mystery. Sarasin was a passionate lover of nature and an ardent student of the geophysics of his native land. We can but refer to the instrument invented by him for recording the "seiches"—those strange undulations which from time to time traverse the Lake Leman, and to his photographic studies on the penetration of light under water.

The reader who desires a fuller information as to the work of Sarasin is referred to the interesting article by C. E. Guye in the *Journal de Genève* of June 26, as well as to the forthcoming account by L. de la Rive in the Archives des Sciences.

GRACE CHISHOLM YOUNG.

NOTES.

SIR GEORGE GREENHILL reminds us, in connection with the correspondence on unusual rainbows in NATURE of August 30 and September 6, that letters upon this subject appeared in NATURE of January 23 and February 6, 1890 (vol. xli., pp. 271 and 316). In the issue of the former date Lord Kelvin sent a letter, with a diagram, showing a rainbow caused by reflection, and this was followed on February 6 by an illustrated description of eight rainbows seen at one time by Dr. Percival Frost. Lord Kelvin, in sending this letter, said:—"The theory of the rainbows produced by the sun itself directly, and by the image of the sun reflected from still water, is given in Prof. Tait's book on 'Light.' The phenomena seems to have been observed by Halley in 1698 (see NATURE, vol. x., pp. 437, 460, and 483 for interesting correspondence on the subject)." Referring to the observation described in NATURE of August 30, Mr. J. H. Grace writes from Cambridge to direct attention to a note in the Transactions of the Royal Irish Academy, bearing date November 14, 1826, and written by the Lord Bishop of Down and Connor, where there is a striking coloured diagram which illustrates the point raised by Mr. Low. The Bishop remarks: "It cannot be doubted that the extraordinary, or centre, bow was occasioned by the image of the sun reflected from the surface of the water. The description and the figure answer exactly to this explanation."

THE Tokyo Press publishes the scheme for the inauguration in that city of a scientific and industrial research laboratory. The principal scope of the institution is to assist in the application of modern methods to the development of Japanese industries. The chief sections of the laboratory will be those devoted to researches in electricity, chemistry, electrochemistry, textiles, and metallurgy. To meet the expenses Parliament has passed a law authorising the Government to make a grant to the laboratory of two million yen (approximately 200,000*l.*), payable in instalments over ten years at the rate of 200,000 yen per annum. The Imperial Household has also made a lump sum grant of one million yen (100,000*l.*). At a recent meeting the promoters of the scheme elected a committee the object of which will be the collection of funds independent of the Government grants. A sum of 2,900,000 yen (290,000*l.*) has already been collected, so that the laboratory will have available funds exceeding five million yen (half a million sterling). These particulars are taken from a paragraph in *L'Economista d'Italia* for August 30.

DURING the last three strenuous years, much has been done to organise chemical industries, and there is every reason to hope that in the difficult period after the war they will be able to present a united front to the problems which await solution. The very influential Association of British Chemical Manufacturers is now firmly established and doing much good spade-work. It is a hopeful sign that a healthy spirit of give-and-take is abroad, and the amalgamations which have been announced from time to time—notably that recently made public of the firms engaged in the explosives industry—are pregnant with meaning for the future. One of the most important industrial problems of the immediate future is the relation between capital and labour. A body provisionally termed the Wages Committee of Chemical Manufacturers, but which will shortly have a more national title, has been called into being for this purpose, and has already received the support of the majority of chemical employers. Its immediate object is the adjustment of wages questions arising out of the present abnormal cost of living, but ultimately it will probably act together with the trade union representatives as the clearing-house for all questions affecting the relation of masters and men in the industry on the lines suggested by the Whitley Commission. Although the association and the Wages Committee are necessarily separate bodies they will work together in the closest harmony. We have received particulars of the formation of a new body with the title of the National Association of Industrial Chemists, which appears to be a trades union of industrial chemists. The objects of the new body are the economic, intellectual, and social advancement of industrial chemists, and the promotion of the interests of its members by collective action. A start has been made in the Sheffield district, where the new union has received general support. The development of the new association will be watched with interest.

IN an article in the issue of the *Scientific American* for August 18 Mr. C. H. Claudy gives a brief account of the way in which the resources of science are being mobilised for war by the United States. He explains how the National Research Council, the constitution of which has already been described in these columns, is acting as the Department of Science and Research of the Council of National Defence—which means that practically every research laboratory and practically every man of science is at the service of the United States, and to a large extent now engaged in war work. The National Research Council includes the chiefs of the technical bureaus of the Army and Navy, heads of Government bureaus engaged in scientific research, and groups of investigators representing educational institutions, research foundations, and representatives of industrial and engineering research. The representatives of the Government were appointed by the President. The chairman, Dr. G. E. Hale, the director of Mount Wilson Solar Observatory, is giving his entire time to the work in Washington. The work of the council is being done by about thirty-one committees, and naturally no details of the results of their labours are available for publication. As an example of the activities of the council it may be said that the Physics Committee is engaged in an exhaustive study for detecting submerged submarines and mines, in studying and devising range-finders of various types and instruments for the discovery of invisible aircraft and sapping parties, as well as in making improvements in wireless and other instruments used in the air. The greatest research laboratories, outside those of the universities, are maintained by some of the large manufacturing establishments. Several of these have not only offered their services, but have turned over whole staffs of experts, as well as the most complete of laboratory equipments, to the work of the council. Mr. Claudy sums up the work of the council by saying it can be considered as a clearing-house for men of science, a mobilising office for scientific facilities. "It provides the short cut between the man who knows the problem and the men who may find the answer. It has made a solid unit out of the laboratory and research facilities of the country and provided itself with such complete information that there is practically no question which Army or Navy can ask of science that it cannot supply the best man, the best equipment, to attempt to find the answer."

WE notice with regret the announcement in the *Times* of September 8 that Prof. Adolf von Baeyer, foreign member of the Royal Society, and Liebig's successor in the chair of chemistry at the University of Munich, has just died in his eighty-second year.

DURING the past season Dr. Smith Woodward has spent six weeks, partly in association with Prof. Elliot Smith and Major C. Ashburnham, in exploring the Piltdown gravel. Although a large amount of undisturbed material was sifted and carefully examined round the periphery of the pit in which the original discovery of Eoanthropus was made, nothing was found except one unimportant fragment of the tibia of a deer.

THE *Times* announces the death on September 10, on the eve of his eighty-seventh birthday, of Mr. Percy G. Westmacott, one of the notable engineers of the middle of last century. Mr. Westmacott was a pioneer in the use of hydraulics, specially for cranes, lock-gates, bridges, and grain elevators, etc., the swing bridge at Newcastle being one of the best-known examples of his inventions in this line. He collaborated throughout in the construction and development of the famous Armstrong gun. He was president of the Institution of Mechanical Engineers in 1883 and 1884, and only gave up his close association with engineering work in 1887 owing to ill-health.

THE ninety-ninth annual meeting of the Société Helvétique des Sciences Naturelles is being held this week at Zürich. The following lectures are included in the programme:—Prof. A. L. Perrier (Lausanne), The orientation of molecules in physics and crystallography: a sketch of a fruitful hypothesis and its consequences; Prof. F. Baltzer (Bern), The development and heredity of bastards; Prof. R. Chodat (Geneva), A botanic voyage to Paraguay; Prof. E. Bleuler (Zürich), The newest psychological directions in psychiatry and their importance in other subjects; Prof. E. Argand (Neuchâtel), the phases of alpine folding; Friedrich Schmid (Oberhelfenschwyl), The zodiacal light, a chapter in meteorological optics.

THE loss of its librarian, Mr. E. E. Riseley, who was killed in action on August 1, will be severely felt by the Linnean Society. Mr. Riseley was born at Abbots Ripton, on February 15, 1889, the only son of his parents, and at the age of fifteen became library clerk to the Zoological Society; there he acquired an excellent knowledge of zoological literature and library methods, which stood him in good stead when he became assistant librarian to the Linnean Society in the spring of 1914. From the autumn of that year he was the librarian, and his energy resulted in great improvements in the arrangement of the books, whilst his quickly gained knowledge of the special volumes in the library, made his services greatly appreciated, and a long career seemed to be his, when it was suddenly cut short by his death.

BY the death of Prof. Eduard Buchner, professor of chemistry, Breslau University, on the Western front near Verdun, Germany has lost one of her most distinguished workers in the field of biochemistry. It was in 1897 that Buchner made the memorable observation that the yeast-juice prepared by Hans Buchner (his brother) and Martin Hahn, by grinding yeast with sand and pressing out with kieselguhr, had the power of fermenting sugar, although it was quite free from yeast cells. Thus was solved a problem which had defied the experimental resources of Pasteur and many others of less renown, and thus was established the fundamental principle that processes of fermentation are not inalienably dependent on the life of the organism, but are carried out by chemical agents, which may be removed from the cell without loss of function. Buchner's discovery, established in the face of strenuous criticism by careful and thorough experiments (collected and published in "Die Zymasegärung"), was received with intense interest by the scientific world, and acted as a great stimulus to research in biochemistry, the effects of which are by no means yet exhausted. Buchner himself was awarded a Nobel prize in chemistry (1907) and received the honours bestowed by Germany with unsparing hand upon her successful men of science. The experiments were extended to bacteria, and, although unexpected difficulties were encountered, it was proved that the same principle applied to these, the simplest of all living organisms. The work of Buchner must be regarded as marking a definite step forward in the exploration of the mysteries of the living cell. By it the frontier of chemical and physical explanation is advanced a stage and the unexplained residuum is at once diminished in area and more clearly outlined.

MAJOR A. N. LEEDS, whose death on August 25 we have already announced, was born at Eyebury, Peterborough, on March 9, 1847, and educated at the Warwick Grammar School. His early ambition was to enter the medical profession, but circumstances compelled him in 1868 to take over the management of the farm of his deceased father. There, in association with his brother, Mr. C. E. Leeds, who was then studying at Oxford, he became interested in the fossil bones of reptiles found in the brickfields in the Oxford Clay near Peterborough, and he spent the leisure of the rest of his life in collecting these fossils in a manner more systematic and scientific than had ever been attempted before. For about twenty years the two brothers worked together, until Mr. C. Leeds left this country for New Zealand. After that Major A. Leeds continued the collecting alone, aided only in the work of preparation by his accomplished wife, and occasionally by one of his sons, Mr. E. T. Leeds, now of the Ashmolean Museum, Oxford. From 1890 onwards all the most important specimens in the Leeds collection were gradually acquired by the British Museum, where they now form a unique series illustrating the osteology of the Ichthyosauria, Plesiosauria, Pliosauria, and marine Crocodilia, besides parts of certain Dinosauria. They are specially valuable because all the bones are completely extricated from the soft clay in which they were embedded, and many of the skeletons can be mounted like those of modern animals. The marine forms are described by Dr. C. W. Andrews in two exhaustive and well-illustrated volumes published by the trustees of the British Museum. Major Leeds also discovered many new fishes, which were described by Dr. Smith Woodward. In recognition of the scientific value of his work he was awarded the Lyell Fund by the Geological Society in 1893.

THE Departmental Committee appointed to inquire into the condition of the freshwater fisheries, as a possible emergency source of food, has issued an interim report. The investigation, which was carried out mainly by means of a *questionnaire*, dealt with trout, eels, and other coarse freshwater fishes, but not with salmon. The committee does not regard the available stock of such fishes as of much importance as an emergency food supply, and does not recommend any interference with the existing rights of owners and anglers. Most of the waters are privately owned, and the fish are therefore private property, so that exceptional exploitation would imply the payment of compensation. There are, it is stated, considerable quantities of migratory fishes, such as grey mullet, in the lower reaches of many rivers. Such waters are public ones, and the committee recommends the modification of any regulations which make the capture of these fishes difficult or impossible. The nutritive value of coarse freshwater fishes is dealt with. There are no available analyses of British species, but the committee gives a list of analytical results with respect to American and French fish. The food value appears to be very low. In a circular (Fisheries Notice, No. 8) sent out together with the report the Board of Agriculture and Fisheries gives a number of recipes dealing with methods of preparation, cooking, and smoking of coarse freshwater fishes.

THE forty-sixth annual report of the Deputy-Master and Comptroller of the Mint for the year 1915 has recently been issued. The outstanding feature of the year, so far as coinage is concerned, was the very great request for Imperial silver coin. The large demands which followed the outbreak of the war appeared to be satisfied by the spring of 1915. In August, however, when measures were taken to withdraw gold coin from circulation, it became clear that further large supplies of silver currency would be required. As against an average of under forty million silver pieces for the ten years 1905–14, no fewer than 105 million new silver coins were minted. In all more than 206 million new coins, of the value of 29,148,392*l.*, were put into circulation. The issue of gold coin was also above the average of the previous ten years, but was considerably below that of the four years 1910–13. Returns of gold coin held on June 30, 1915, were made by sixty-eight banks, and the total, 110,188,109*l.*, is the largest shown since the institution of the annual inquiry, exceeding the amount held in 1914 by more than twenty-seven million pounds. Compared with the results of the inquiry in 1909, when the returns of holdings were made on the same weekday, the total held in 1915 shows an increase of nearly 124 per cent. The profit on the year's working was 4,710,291*l.*, and was much the largest in the history of the institution. The increase was chiefly due to the profits on the large sales of silver coin in the year.

IN vol. xii., part 10, of the Publications on American Archæology and Ethnology, issued by the University of California, Mr. S. A. Barrett describes the ceremonies of the Pomo tribe. Twenty years have passed since the last of the Pomo ceremonies was held in true aboriginal fashion. Elaborate rites of the more recently introduced "Messiah" cult were held so late as fifteen years ago, but these include only a few features common to the indigenous tribal observances. The details of the chief ceremonies have now been collected from the recollection of aged members of the tribe, and the description contains much that is interesting. The tribal rites were characterised by the absence of any fixed ceremonial season or sequence of ritual, and they were not controlled by a powerful priesthood or secret order in charge of the observances. The ritual mainly consisted of dances, some of which were adopted as integral parts of certain ceremonies, while others were merely incidental to them. One ceremony had a definite mythological background, but at the present day no myths are told to explain several parts of the rites. A distinguishing feature was the prominent part played by the women.

In two dances the number of performers drawn from each sex was definitely prescribed; in five only men might participate, and two were exclusively performed by women.

Under the title of "Fuel Values of Foods," an article by Dr. C. F. Bolduan, of New York, appeared in the *Scientific American* of July 28, in which a novel method is indicated of bringing home to the public the importance of knowing the real nourishing value of the foods they buy. This consists in attaching to each food displayed for sale a card indicating its calorie value per lb. The calorie value is the best all-round index of the nourishing properties of a food. The older idea of attaching special importance to the protein content is now discarded, since it is practically impossible to obtain any combination of natural foods suitable for human use which does not provide sufficient of this foodstuff. To complete the lesson the price per lb. of each food should be attached as well. Dr. Bolduan is a well-known authority on subjects dealing with public health, and at his suggestion one firm of restaurant proprietors has adopted the principle of giving, in parentheses on the *menu*-card, numbers which indicate the calorie value of the dishes offered for choice. Thus "(632–429) cold ham or corned beef, potato salad, 20 cents," indicates that the portion supplied, if ham were selected, would have 632 calories, if beef were chosen 429 calories. A similar practice has long been in use at the Battle Creek Sanatorium. The article is accompanied by a full-page illustration of a suggested window display of foods on these lines, in which fruit, vegetables, nuts, cereal foods, fish, poultry, meat of various kinds, etc., are all included. Other illustrations represent tables laid out with (1) a breakfast, which supplies 650 calories; (2) a lunch providing 900 calories; and (3) a meatless dinner of 1100 calories, the whole being sufficient for a man leading a sedentary life. It is not unlikely that we may soon see this method of teaching economy in the use of foods adopted in this country.

The claim of the gipsy moth (*Ocneria dispar*) to rank as a British species, its former abundance in the fen districts, and its final disappearance throughout Great Britain, are very clearly set forth by Mr. Robert Adkin in the Proceedings of the Entomological Society for 1916–17. There seems to be no justification for the belief, at one time held, that this was an introduced species, though it is curious that it was unknown to the older entomologists. At no time does it appear to have become unduly numerous with us, though in North America, where it was accidentally introduced, it has become a formidable pest.

The existence of fluorescent bacteria has been recorded, though the colouring matter produced by them is insoluble in ether. Further, E. Rostrup has observed that *Agaricus* (*Pleurotus*) *serotinus*, Schrad., imparts a peculiar fluorescence to spirits of wine, and A. Ling found that a Torula occurring in ale gave to it a greenish fluorescence. Now Prof. A. Klocker (*Comptes rendus des travaux du Laboratoire de Carlsberg*, vol. ii., part 6) describes the production of a faint greenish fluorescence when *Aspergillus glaucus* is grown in a medium containing sugar, and the isolation of the colouring principle. When the medium (*e.g.* beer wort) in which *A. glaucus* has been grown is shaken with ether, the latter acquires a faint yellowish colour, and in thick layers a blue fluorescence. If the ethereal solution is shaken with ammonia this exhibits a very marked green fluorescence, whilst if soda be used the fluorescence is reddish-brown. On evaporation the ethereal solution leaves a yellow residue having the properties described. The substance is not fluorescein, though it resembles this compound. If the Aspergillus is grown on gelatinised beer wort the liquefied gelatine develops the fluorescence. The reaction seems to be specific for *A. glaucus* and *A. repens*.

Dr. John Tait has published in vol. xxxvii. of the Proceedings of the Royal Society of Edinburgh a series of five papers under the general title of "Experiments and Observations on Crustacea." Some of the questions dealt with are purely physiological, as in the case of the first paper, which gives the results of experiments on the resistance of the terrestrial Isopod, Ligia, to immersion in fresh and in salt water. It was found that while immersion for prolonged periods in sea-water had little, if any, harmful effect, some of the specimens surviving for three months, distilled water proved fatal, within forty-eight hours, to specimens immersed in it. It is shown that this toxic effect is due, in all probability, to the withdrawal of essential salts from the body of the animal. Several papers deal with problems that are described as "semi-morphological," and in these the author shows a preference for far-fetched comparisons that seems to be characteristic of medical physiologists who touch on comparative morphology. The way in which the leg of the Isopod Ligia is bent is illustrated by "selecting, say, the limb of a land mammal for comparison." We are told that the correlation between the two is "sufficient to excite wonder." One paper gives an account of some points in the structure of the giant Antarctic Isopod, Glyptonotus, and includes the most detailed account yet published of the articular surfaces of a joint in the leg of a Crustacean.

In an article in the *Revue générale des Sciences* for June 30 and July 15, Dr. Legrand expounds a theory of heredity which he calls "L'emboîtement des Plasmas." He distinguishes in every inheritance between the fixed specific characters and the non-fixed sexual, varietal, atavistic, and parental characters. The fixed hereditary characters have their localisation in the specific cytoplasm, while the chromatin apparatus of the nucleus is the vehicle of the non-fixed characters. The fertilised ovum (or "the original trinitary block") consists of the ovum-cytoplasm with the fixed specific characters (a view for which there is a good deal of experimental evidence) and a nucleus containing the varietal, atavistic, and individual plasmas (respectively maternal and paternal), which the author pictures as segments of a spheroid, overlapping one another (like young leaves in a bud) with the most recent to the interior. According to the particular plan of the bud or *emboîtement*, different nuclear blocks will have different degrees of contact with the cytoplasmic envelope, and this affords a sort of mechanical symbolisation of paternal or maternal preponderance, of latent and patent characters, of male or female sex (which seems to us to get mixed up with paternal and maternal respectively). Dr. Legrand draws ingenious diagrams expressing the results of experiments on the inheritance of coloration in mice, or a familiar case like the hereditary composition of a mule. He seeks to illustrate by a "complex visible" model the "simple invisible" reality. Starting from the meticulous longitudinal splitting of the chromosomes and the orderly movements of karyokinesis, he develops the idea that the cytoplasm supplies the indispensable specific foundation, and that the minor details of the developing edifice are due to the way in which the factors of the non-fixed characters are disposed within the nucleus in relation to one another and to the environing cytoplasm with which there is interaction. To us the theory appears only a diagram; to Dr. Legrand it is much more.

PART 2 of vol. ii. of the Memoirs of the Kyoto University contains an account of the recent measurements made by Messrs. T. Takamine and S. Nitta in the extreme ultra-violet portion of the spark and arc spectra of a number of metals. The sparks were produced by the Hilger apparatus, and the arc in a vacuum lamp, between poles of the metal to be investigated. The spectra were obtained by means of either of two Hilger quartz spectrographs, and were photographed on Schumann plates. The wave-lengths were calculated from the measurements of the plates, the lines of the silver and iron sparks as given by the Blochs being taken as standards. The spark spectra of silver, aluminium, gold, bismuth, cadmium, cobalt, iron, manganese, antimony, and thallium in the region 2000 to 1830 were examined, and a number of new lines found for each element. In the cases of manganese and platinum the whole of the lines are new. The vacuum arc spectra of bismuth, antimony, and thallium gave several new lines in the same region.

IN a paper read before the R. Accad. delle Scienze dell' Istituto di Bologna, in March of this year, Prof. A. Righi returns to the question of magneto-ionisation, already dealt with in previous papers. A beam of X-rays ionises the gas between two metal plates which are suitably connected to an electrometer and an accumulator battery. A magnetic field can be created in a direction parallel to the plane of the plates. Without the latter field the voltage-current curve shows the usual features of a saturated phase followed by one in which ionisation by collision is prominent. When a magnetic field of 430 gausses is super-imposed, there is found a current decrease for the lower voltages, *i.e.* in the earlier portion of the saturated phase, but for voltages of 400 or above the current is slightly increased. This is ascribed by the author to the action of the magnetic field in promoting ionisation. In the opinion of the writer of this note Prof. Righi's interpretation of his results is by no means the only one which is possible, and though his ingenious experiments are of great interest, his theory will need further support before it obtains general acceptance. In particular, it will be necessary to show that the increase of current is not caused by the oblique, and therefore longer, paths of the ions under the joint actions of the two fields. When the saturated phase is passed, any increase in the distance travelled over by the negative ions means more opportunities for the production of further ions by collisions, and this may be all that is necessary to explain the results.

IN *La Nature* for August 11 M. Guillaume gives some interesting information concerning the work of the Bureau International des Poids et Mesures, of which institution he is director. As is well known, the Bureau has custody of the primary standards relating to the metric system, *i.e.* length and mass. This involves fairly frequent restandardisations and comparisons of the secondary with the primary standards. The institution also undertakes the verification of the standards of other countries which subscribed to the Convention du Mètre in 1875. Dilatation measurements also play an important part in the operations of the Bureau. Two methods are used, viz. the comparator and dilatometer methods, the former being used for large bars (generally 1 metre in length) and the latter for test-pieces the greatest dimension of which is of the order of 1 cm. These measurements are important, not only because it is necessary to know accurately the dilatation-coefficient of all standards issued from the institute, but also by reason of the fact that such measurements are employed in investigating metals and their alloys. The numerous applications of the nickel-steels for industrial purposes originated at the Bureau. It is interesting to note that most of the geodetic survey standards at present in use in the world have been verified at the Bureau International on a geodetic comparator (or tape bench) erected specially for that purpose. A large universal comparator is in use for determining the values of the various subdivisions of the metre now widely employed, the values being checked to within a few tenths of a micron (0·001 mm.). Reference is made in the article to the important work carried out by Michelson, in collaboration with Benoît, on the measurement of wave-lengths, using a cadmium lamp as standard; and to similar experiments undertaken fifteen years later by Benoît, Fabry, and Perot, which agreed with the results of the earlier investigations to within 1 part in 10,000,000. The use of *invar* (the nickel-steel of very low expansion-coefficient), which was promoted by the researches of the Bureau, has now extended to horology and metrology (bars and tapes) and in other directions.

THE use of alcohol as a fuel in the internal-combustion engine and the possibilities of manufacturing it economically in Australia are discussed by Mr. W. T. Rowe in Bulletin No. 8 of the Department of Chemistry of South Australia. Alcohol has some obvious advantages over petrol, such as its greater safety in storage, freedom from unpleasant smell, and constant composition, but in addition its vapour when mixed with air will stand a much higher compression without pre-ignition. In suitably constructed engines the efficiency per b.h.p. for alcohol is 28 to 31 per cent., as compared with 16 to 20 per cent. for petrol. One of the chief causes militating against the use of alcohol industrially is the restrictions of the revenue authorities, but denatured alcohol would form a good motor spirit provided that methyl alcohol were *not* used as a denaturant. Benzol or petrol is recommended for this purpose. Alcohol can be economically manufactured from substances grown in Australia, and might thus form a valuable industry. The supply of non-utilised molasses in the whole of Australia is insufficient to yield the amount of alcohol equivalent to the petrol imported by South Australia alone; considerably larger quantities of straw are available, however, but its use on a commercial scale has not yet been tried. In South Australia the raw materials offering the greatest promise are wheat, barley, potatoes, straw, and perhaps beet, but, except the straw, these would have to be specially grown to yield enough alcohol to replace the imported petrol. Using wheat or potatoes, the cost of raw material is approximately the same, because, although wheat contains more starch, potatoes give a greater yield per acre; in each case the total cost of the spirit would be from 1*s*. 9*d*. to 3*s*. 6*d*. per gallon, according to the price of the raw materials.

IN the Proceedings of the Tokyo Mathematico-Physical Society, vol. ix. (2) 4, Mr. Hantero Nagaoka obtains equations for evaluating the maximum force between two circular electric currents, and suggests uses for the calculations in connection with electric methods of comparing the intensity of gravity at different places on the earth.

A NOTE on a modification of the epicycloidal method of tracing the profiles of toothed wheels is the subject of a note by Prof. T. Levi Civita in the *Atti e memorie* of the Padua Academy, vol. xxxiii., 11 (Padua: Giov. Batt. Randi, 1917, pp. 8). In it use is made of the "line of action," which is the locus, traced in space, of the point of contact of the wheels as they revolve.

THE catalogue (No. 168) of second-hand books just issued by Messrs. W. Heffer and Sons Ltd., Cambridge, contains particulars of many interesting, and some scarce, works in anthropology, archæology, folklore, mythology, botany, geology, mathematics, astronomy, and physics. We notice in the astronomical section a set of the *Astrophysical Journal*, and the "Nautical Almanac" for 1875–1916.

OUR ASTRONOMICAL COLUMN.

RELATIVITY AND GRAVITATION.—According to the original form of the theory of relativity, an absolute velocity v in space cannot be determined by any physical means, all matter as well as electrical and optical fields being contracted, in the terminology of the older physics, in the same ratio $(1-v^2/c^2)^{\frac{1}{2}}$. Using the same terminology, Einstein's recent gravitational theory requires a gravitational field to suffer contraction in this same ratio, so that an absolute velocity v must remain for ever hidden from our knowledge. Einstein has shown that this theory, suitably generalised to cover independently-moving bodies, leads to changes in the perihelia and eccentricities of the four inner planets which agree well with those observed. In the *Phil. Mag.* for August Sir Oliver Lodge suggests an alternative explanation of the changes in Mercury's orbit. In accordance with pre-relativity theory, the mass of Mercury, when moving with velocity v, is supposed to be $m_0(1-v^2/c^2)^{-\frac{1}{2}}$; of this only the stationary mass m_0 is supposed subject to gravitation, while the sun's gravitational field is not supposed to suffer distortion as it moves through space. The assumed increase in inertia, uncontrolled by gravitation, is found to lead to a revolution of Mercury's orbit in its own plane, which will agree with that observed if the sun has a velocity of about 68 km. a second towards longitude 294°. This velocity would also give an apsidal progression for Mars about equal to that observed, but in the September *Phil. Mag.* Prof. Eddington has shown that it would give orbital distortions for the earth and Venus enormously greater than those observed. In these papers no allowance is made for the distinction between longitudinal and transverse electromagnetic mass, but it seems impossible that this correction could reconcile theory with observation; indeed, the discussion suggests that no theory of the general type suggested by Sir Oliver Lodge can be made to fit all the facts, so that the relativity theory appears to be left in a stronger position than ever.

PHOTOGRAPHS OF NEBULÆ.—A remarkable collection of photographs of nebulæ taken with the 60-in. reflector of the Mt. Wilson Observatory has been published by Mr. F. G. Pease (*Astrophysical Journal*, vol. xlvi., p. 24). The objects selected were in general nebulæ of unknown structure, or nebulæ which were known to exhibit unusual features. Most of the exposures were made with aperture ratio F/5, but several of the bright planetary nebulæ were also photographed with the 80- and 100-ft. focus Cassegrain arrangements of the telescope, in order to give a larger scale. The exposures ranged from ten minutes to seven hours. It is interesting to note that the perfection of the photographs was increased in the case of very long exposures by the use of two guiding stars, which allowed of correction being made for variation in size and for rotation of field produced by refraction and imperfect adjustment of the telescope. In addition to the sixty-five nebulæ which are fully described, attention is directed to others which appeared incidentally on the plates, and to a number of uncatalogued nebulæ and nebulous stars. The photographs show a great amount of intricate detail, and bear witness alike to the excellence of the instrument and the skill of the observer.

THE 100-IN. REFLECTOR AT MOUNT WILSON.—An illustrated description of the great reflector of the Mount Wilson Observatory is given by Mr. Pease in the *Scientific American* for August 11. As supplementing the account already given in the columns of NATURE of July 12 (vol. xcix., p. 385), it may be noted that the moving parts of the telescope, which is mounted on the English pattern, weigh 100 tons. The greater part of the weight is taken up by the mercury flotation system, 40 tons at the north pedestal and 60 tons at the south pedestal. The driving clock is regulated by an isochronous governor of the conical pendulum type, and the weight is wound up automatically at intervals of twelve minutes without interference with the driving. The clock itself stands 6 ft. high and occupies a floor space of 5½ ft. by 4 ft. The actual diameter of the mirror is 101·2 in., and its focal length 507·5 in., giving an aperture ratio of 5·05. Elaborate arrangements have been made to maintain the mirror at constant temperature by water circulation. Manipulation of the dome and telescope involves the use of forty motors of 1/20 to 7½ horse-power, with an aggregate of 50 horse-power and more than thirteen miles of wiring. It is estimated that about 300 million stars will be within range of the new instrument.

INDUSTRIAL FATIGUE.[1]

UNDER the above title Prof. Spooner has collected articles written by him in 1916 for publication in *Co-partnership*. The pamphlet is a useful contribution to the discussion of reconstruction, which already is receiving anxious attention from many who realise its extreme importance and its extreme difficulty.

Evidently in so small a space but few details can be given, but the author has touched upon many points which show how wide is the problem and how great are the difficulties which surround it. Perhaps the main impression left upon the mind after a perusal of these fifty-nine pages is one of the immense amount of scientific investigation which remains to be done before industrial processes—to say nothing of industrial management can be placed on a thoroughly satisfactory footing. It is only quite recently, and largely on account of present conditions, that the general public and directors of industry have begun to realise that science after all is merely crystallised and systematised knowledge, and that to attempt to conduct industrial processes without it is to dispense with one of the greatest aids to success. Now, however, the leaven is spreading. Many firms operating processes which depend on scientific principles have their own scientific staff working in admirably equipped laboratories, and so far as their own processes are concerned little more is needed, though it would undoubtedly contribute to the general advance if the results of the investigations carried out could be made available for all to profit by. But apart from these questions there are larger problems which affect all industries, and which can only be dealt with effectively by some central authority. Such, for instance, is the question of the number of hours' work per week which will enable an operative to produce the largest output without injurious fatigue. Evidently no general answer can be given to such a question. The answer must vary with conditions, and all conditions must be studied in order that their influence in producing fatigue may be determined. But certain fundamental facts may be established, and perhaps the most im-

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[1] "Industrial Fatigue in its Relation to Maximum Output." By Henry J. Spooner, C.E. Forewords by Sir Robert Hadfield, F.R.S., and Mr. J. R. Clynes, M.P. (Co-partnership Publishers, Ltd., 6 Bloomsbury Square, W.C.1.) Price 6*d.* net.